Abstract

This thesis is concerned with issues that are relevant in the context of planning, design and operation of electric power distribution systems, particularly of developing countries The specific problems considered in this thesis are loss estimation in the absence of complete measurements, assessment of shunt compensation strategies, methods of automatically generating one-line diagram in situations where sophisticated planning tools are not available, power flow studies of distribution systems with multiple sources and use of data compression techniques for archiving power system data being generated through means of digital measurements

Energy losses in distribution systems are generally estimated rather than measured, because of inadequate metering in these systems and also due to the high cost of data collection These estimations are generally based on some rules of thumb Recent trends towards restructuring of distribution systems has accentuated the need for utilities to develop more reliable loss estimation methods

The various issues that concern loss estimation are addressed Here, based on data collected from feeders specially instrumented for this purpose, true losses in some primary and secondary feeders are obtained These losses are compared with the estimated losses obtained by the methods presently in use In view of the large discrepancies observed between measured and estimated values, two new schemes for estimating losses in primary and secondary distribution networks have been developed The measured values are used to highlight the reliability of the new estimation methods

The distribution feeder one-line diagram, is a very useful means for visualizing the system for various planning tasks Manual methods, that are presently provided with most GUI software, for generating such diagrams, are extremely cumbersome and error-prone Drawing algorithms that can generate the co-ordinates of the buses automatically are needed

Two algorithms for automatically generating 'readable' one-line diagrams of radial distribution feeders are proposed here A set of layout specifications for the drawing, that ensure good visualization of distribution systems, are evolved It is assumed that only the identity of the terminal nodes of all the edges are known, the node positions are automatically determined Results of application of the algorithms on practical feeders are shown

The application of shunt compensation for energy loss reduction is a widely researched problem A number of compensation schemes are in practice, and several new ones are being proposed However, accurate assessment of the different designs has rarely been done using actual operational data

In order to assess the effectiveness of the various compensation schemes, studies are carried out based on complete load data (collected over several months) from three practical feeders Using this data, the effectiveness of fixed as well as switched compensation schemes are assessed, an alternative fixed compensation scheme is proposed and its effectiveness is assessed Two switched compensation schemes are presented, impact of various design parameters such as step size of switching etc , are assessed through simulation studies The implications of the findings of the study in the context of the current compensation design practices are highlighted

Distribution feeder power flow analysis methods have been traditionally developed for radial systems with unidirectional power flow Over the years, additional devices in the form of distributed generation, static var compensators, switched capacitors and voltage regulators, have been integrated into the distribution system Therefore, it is necessary to evolve methods that incorporate these devices into the power flow program In this context, a power flow method that can be used for radial systems having all the common types of voltage control devices (switched capacitors, static var compensators, voltage regulators) in addition to distributed generation sources (synchronous and induction generators) is proposed

The use of digital instruments in power systems, is contributing to the increase in the number of quantities measured as also the frequency of measurement Most of the data that is acquired through the vast network of instruments is rarely immediately used and discarded, they need to be archived for facilitating later use for planning, analysis, trouble shooting etc Even as the cost of memory and communication is coming down, the data that is to be communicated

and stored is also increasing at a rapid pace

The investigations presented here explore the application of data compression techniques for the purpose of archiving one important operational data- the load curve data The techniques (Vector quantization and Discrete wavelet transform) are applied for archiving load curves at different levels such as the load curve of an utility, load curve of a bulk consumer and load curves at the primary distribution level One application of data compression has been demonstrated through classification by using the classified data to estimate losses in a feeder

A noteworthy feature of the thesis is that all the studies and algorithm validations have been carried out considering data of practical systems